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TAGGING AND MARKING FISH

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The principal objective of fishery investigation is to obtain the scientific knowledge necessary for the proper management of each of the fisheries, so that the maximum harvest consistent with the perpetuation of the stock is secured each year. The fishery investigator is particularly concerned with fluctuations in abundance, their causes, and their influence upon the yield of the fishery. One of the most useful techniques employed in the collection of scientific data pertaining to the abundance and life history of each species is the release and subsequent recapture of marked fish. There are two general methods of marking fish, one being the amputation of one or more fins of the fish, and the other being the attachment of tags to the fish. The primary purpose of both is to make possible the identification of an individual, or a group of individuals at some later date. The techniques employed are more fully described in subsequent paragraphs of this paper under the heading of methods.

OBJECTIVES

In cases of important marine fishes that are extended over great distances of coast line or are widely distributed among off-shore banks it is especially important to know the degree of interdependence between the populations of the several areas. Are the several fishing banks supported by a single population which distributes itself widely over the fishing areas, or is each locality supported by a separate population restricted in its distribution to the limits of that area alone? In the first case overfishing in one area might have a less serious effect upon abundance since replenishment through immigration from other areas would occur, whereas in an area supported only by a resident and independent population overfishing must result in a steady decline in abundance with the consequent danger of depletion of that stock. The degree of interdependence between populations of several areas can be determined by marking fish in each of the several areas and then obtaining data on the locality of recapture of the marked individuals.

A knowledge of the migration route, the time, and the rate of migration is of importance in regulating the fishery for many species. This is particularly true in the case of salmon which are taken by the fishery as they are migrating to the spawning areas. In order to obtain an adequate

spawning escapement in each area, it is necessary to know when the fish are being taken, where they are being taken, and the fishing intensity imposed on each group or "race" of fish. This information may be secured either by marking immature individuals as they are migrating to the ocean or by marking the adults as they first appear in the fishery. In either case, the time of appearance, the rate of migration, and the intensity of fishing can be determined by the recovery of marked individuals.

Another very useful application of marking is that it provides a means of direct estimation of mortality including both that caused by the fishery and that which arises from natural causes. From the proportion of the number of recoveries each year to the original number marked, it is possible to calculate the percentage loss. Such figures must be adjusted however, since the number of recoveries will be influenced by the mortality incidental to marking, and also by the amount of fishing effort expended in the various years. To determine fishing mortality alone, marked individuals must be released immediately prior to the fishing season, and there must be a reasonable assurance that they distribute themselves at random among the commercially fished population. If this be so, then the fishing mortality is computed from the simple ratio of the number of recoveries during the season to the total number marked, provided proper allowance is made for natural mortality and the mortality incidental to marking.

Marking also provides a means of estimating the total number of fish in the population, since the ratio of the number marked to the total population is the same as the ratio of the number of recoveries to the catch. In the case of anadromous species it is often desirable to determine the number of fish that ascend a river to spawn. In this event individuals captured near the river mouth are marked with conspicuous tags and then released to resume their migration upstream. Observers are assigned to patrol the river bank to determine the ratio of marked to unmarked fish. Knowing this ratio and the number of fish originally marked, it is possible to calculate the total number of fish on the spawning grounds.

The determination of the age of the individuals in a population is an essential part of most investigations. Marking serves as a valuable check on the methods usually employed, since the interval between the time of liberation and the time of recovery is definitely known. Similarly marking can be used to establish the rate of growth since the fish may be measured both at the time of liberation and recovery.

In fish cultural activities conducted by the state and federal governments it is extremely important to know the proper size and time for liberation of the young fish. The hatchery operator can determine the optimum rearing period by marking a series of size-groups and observing which group has the highest proportionate return.

HISTORY

The marking of fish by various means for the purpose of securing information on their migratory movements had an early start in the course of fishery investigations. Contained in the literature is a record of

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sixteen such experiments conducted in Scotland between 1823 and 1875. A number of methods of marking other than by fin cutting were tried, such as attaching copper or silver wire to various parts of the fish, and attaching gutta-percha labels to the tail by rubber rings. Probably the first organized marking experiment under the auspices of a government agency was by the United States Fish Commission in the years 1872-1875 on the salmon of the Penobscot River, Maine. Mr. Charles G. Atkins who conducted the work used an aluminum tag stamped with a serial number and held by a rubber band slipped over the tail. This tag was later discarded in favor of an aluminum tag attached to the dorsal fin by means of a fine platinum wire.

While salmon and trout were the first species marked, the method was soon expanded to wholly marine species as well. After 1888 a number of experiments were carried on with the plaice, cod, and other species. These experiments were attended with such success that marking has been an important part of fishery research since that date.

METHODS

Amputation:-- Amputation of fins is practicable only under circumstances that permit the individual examination of large numbers of fish taken in the commercial catch. Such circumstances prevail in the salmon fishery where each individual is counted and separated according to species. Among the advantages of amputation is that it can be successfully used on small fish, both because of the simplicity of the operation involved, and because no allowance need be made for future growth. It is therefore especially suitable for marking young salmon which leave the stream at small size and are not again seen until they return fully grown. Fin amputation is relatively inexpensive and large numbers of fish can be marked by this method. Its principal disadvantage is that it is not applicable to the identification of individual fish.

The essential requirements of this method are that the marks used must not be easily duplicated under natural conditions, and that they will persist throughout the life of the fish. To lessen the chance of duplication through the recovery of fish having fins naturally deformed or missing it is the usual practice to remove two or more fins. To safeguard against regeneration it is necessary that they be amputated close to the body, since fins only partially removed will grow back in a short time. The fins most frequently amputated are combinations of the adipose, dorsal, and ventrals though other fins, such as the anal and the pectorals, have also been removed. Investigators have found that a flat-bladed fingernail clipper is the most satisfactory instrument for the operation.

Strap tag:-- The strap tag, widely used for marking fish, is an adaptation of the tag used by farmers in marking livestock. It consists of a narrow U-shaped metal strip that can be clamped, by means of special pliers, over the caudal fin or the operculum of the fish. This tag includes a relatively large area of tissue in its grasp and for that reason the loss of tags through a wearing-away of the tissue is generally small.

The size of tag used varies according to the size of the fish to be tagged. Those used on adult salmonare 2 5/8 inches long by 5/16 inch wide. The metals most commonly used are monel metal and aluminum because of their resistance to corrosion in both fresh and salt water. Letters indicating the name of the organization conducting the experiment and a serial number are stamped on the surface. This tag has been used successfully on the adults of many species including cod, haddock, salmon and halibut.

Button tag:- The button tag of which there are innumerable variations is two discs attached by a wire which passes through a hole in each disc and also through the flesh of the fish. On many species this has proven more satisfactory than the strap tag.

A great variety of material has been utilized in its construction. When metal buttons are used they must be of non-corrosive material such as monel, aluminum, or silver. Non-metallic substances such as ebonite or bone have frequently been used. These have been superseded in recent years by plastic because of its durability, light weight, and low cost. The plastic buttons are usually in bright colors so that they may be seen easily. The pin or wire holding the two together must be non-corrosive and sufficiently pliable so that it can easily be looped in attaching the tag. Nickel and silver have proved most satisfactory for this purpose.

One button usually is stamped with a serial number and letters representing the organization using the tag, while the other button usually bears a reward notice and instructions for return. The latter is a necessary feature of this tag particularly for people unfamiliar with a tagging program.

There are several suitable positions for attachment of button tags to the body. They are customarily inserted on the gill cover, on the back just below the dorsal fin, or in the fleshy portion of the tail. It is very important that the tag be attached loosely to allow for growth. A great many species have been marked with the button type tag, both in this country and abroad. Species so marked include cod, hake, salmon and many of the flatfish.

Internal tag:-- A comparatively recent development in the technique of marking is the use of the internal tag. It was conceived and developed by fishery biologists of this Service. It consists of a small strip of plastic or metal, having rounded ends, which is inserted into the body cavity of the fish, next to the intestine. It has proven very useful in special cases particularly where there is a high loss of external tags.

The plastic tag, which ordinarily is of a bright color, bears instructions for return on one side and a serial number on the other. Dimensions of the tag vary, but in general it is desirable to use as large a tag as can be tolerated by the fish in order that it may be as conspicuous as possible. In the tagging of small-mouth black bass a tag 9/16 inch long, 3/16 inch wide and 20/1000 inch thick has been used, while a tag as large as 1 5/8 inches long and 1/4 inch wide has been used in marking weakfish. The tag is inserted into the body cavity through a small incision just anterior and dorsal to the vent. Very little mortality has attended the tagging operation even with such delicate fish as shad and young weakfish. The wound heals quickly, the tag usually becomes surrounded by a thin transparent membrane of connective tissue and the fish appears to be entirely

normal within a week.

The principal advantages of the plastic internal tag is its applicability to young fish, the low mortality attending insertion, and the apparent complete normality of tagged fish after recovery from the operation. The latter is an important consideration in fresh water work where the presence of an open wound, such as is inevitable with external tags, is a constant source of danger from infection.

A disadvantage of this method is that it is only suitable for use on species that are cleaned and dressed before marketing and are subject to individual examination. With commercial marine fishes the tag frequently is not detected until the fish has reached the retail market or the ultimate consumer, and in which case it is extremely difficult to determine the date and locality of recapture.

The metal internal tag, except for composition and method of recovery, is similar in application and appearance to the plastic tag just described. The internal metal tag now used for the Alaska herring is approximately 12/16 inch long, 5/32 inch wide, and 1/16 inch thick.

The metal internal tag is used primarily on such marine fishes as herring, pilchard, and menhaden which are caught in enormous quantities and used almost entirely for reduction into meal and oil. External tags have not proven satisfactory on these species since the tags do not remain permanently attached to the delicate structure of the fish. Furthermore, the method of handling large masses of fish prevents individual inspection. In these fisheries it was necessary to develop special methods of recovery and electro-magnets are now used to recover the tags from the conveyor lines of the reduction plants. This method requires that the tag have magnetic properties, and both nickel and steel have been used. Steel is more commonly employed, however, since it meets this requirement better. No significant rusting of steel tags has been found to occur within the body of the fish.

Recovery by means of electro-magnets has the disadvantage that it does not permit exact allocation of the tag as to area and time of recovery. This situation arises from the fact that catches of several vessels are emptied into common storage tanks, and from the fact that tags are sometimes delayed in their passage through the machinery of the plant.

This difficulty of assigning recovered tags to their proper area has been largely eliminated by the development of the electronic tag detecting device which detect individuals carrying metal tags as they are being transferred from the fishing vessel to the storage tanks. The perfection of the electronic tag-detector has materially increased the usefulness of the internal metal tag in marking experiments.